



Oceaneering Space Systems, Inc.

Advanced Worker Protection System

Technology Need:

Much of the work involved in the deactivation and decommissioning (D&D) of Department of Energy (DOE) sites will require difficult tasks to be completed by workers in protective suits and respirators. The suits that will be worn essentially encapsulate the wearer's body, preventing the heat generated by the worker's activity from leaving the suit. The average worker cannot tolerate exposure to the resulting hot, humid atmosphere for more than 45 minutes, after which the worker has to "cool-down" for approximately 1 hour. Including donning and doffing and decontamination time, this makes for a work day that is at best less than 50 percent efficient and frequently only 25 percent efficient. New protection equipment and systems are needed to improve performance.

Technology Description:

The Advanced Worker Protection System (AWPS) is a liquid air based self contained breathing and cooling system. The AWPS employs a patented system developed by Oceaneering Space Systems, Inc. (OSS), that provides the user with breathing air and full body cooling while using only liquid air.

The system has a duration of 2 hours and workers will not require a rest or "cool-down" period after each suited-up session. This should increase the efficiency of each worker by more than 100 percent. The end effect of this system will also decrease the size of the secondary waste stream, decrease the number of workers required for a given task, and decrease the amount of time it takes for each job. Most importantly, the AWPS will create a safer working environment.

The AWPS consists of the primary life support components mounted in a backpack configuration similar to a self-contained breathing apparatus



Worker Wearing the AWPS

(SCBA); a pressure-demand regulator, hose, and mask delivery device; a full-body liquid cooling garment; and outer-garment options of either a splash suit or a totally encapsulating vapor protection suit. The backpack includes the vacuum jacketed vessel or dewar, which contains the cryogenic liquid air. The liquid air is fed through a heat exchanger which uses the water warmed by the wearer's body to vaporize the cryogen for breathing, while it cools the water to control body temperature. The air is regulated to the appropriate pressure and delivered to the face mask. The cooled water is delivered to the full-body cooling garment.

The amount of cooling can be controlled by the wearer. Also, as the wearer breathes harder during higher work rates, more cooling will automatically be provided. A

recharge station is required to fill the dewar on the AWPS with the liquid air. The present design allows this recharge station to be retro-fitted to Self Contained Breathing Apparatus (SCBA) charging units in use today.

Benefits:

- ▶ Full worker protection, air supply, and cooling for over two hours in a single integrated system
- ▶ Improved worker efficiency, shorter and less frequent rest and "cool-down" periods
- ▶ Safer working environment due to less worker stress from protective equipment
- ▶ Easier donning, longer use cycle, and improved comfort during use
- ▶ Potential for significant improvement in management planning and reduction in cleanup costs

Status and Accomplishments:

The AWPS project was divided into two phases. During Phase I, Oceaneering developed and tested a full-scale prototype AWPS. The testing showed that workers using the AWPS could work twice as long as workers using a standard SCBA. The testing also provided performance data on the AWPS in different environments that was used during Phase II to optimize the design. During Phase I, Oceaneering also performed a life-cycle cost analysis on a representative clean-up effort. The analysis indicated that the AWPS could save the DOE millions of dollars on D&D activities and improve the health and safety of their workers.

During Phase II, Oceaneering worked to optimize the AWPS design to increase system reliability, to improve system performance and comfort, and to reduce the backpack weight and manufacturing costs. To support this design effort, Oceaneering developed and tested several different generations of prototype units. Two separate successful evaluations of the ensemble were performed by the International Union of Operation Engineers (IUOE). The results of these evaluations were used to drive the design.

The initial intent during Phase II was to finalize the

design and then to certify the system with the applicable government agencies. Unfortunately, technical and programmatic difficulties prevented them from obtaining certifications from the National Institute for Occupational Safety and Health (NIOSH). Despite the inability to NIOSH certify the design, Oceaneering was able to develop and successfully test, in both the lab and in the field, a prototype AWPS. They clearly demonstrated that a system which provides cooling can significantly increase worker productivity by extending the time they can function in a protective garment. They were also able to develop mature outer garment and Liquid-Cooled Garment (LCG) designs that provide considerable benefits over current protective equipment, such as self donning and doffing, better visibility, and machine washable.

Contacts:

Jud Hedgecock
Oceaneering Space Systems, Inc.
Phone: (281) 228-5409
E-mail: jhedgeco@oss.oceaneering.com

Steve J. Bossart
National Energy Technology Laboratory
Phone: (304) 285-4643
E-mail: steven.bosssart@netl.doe.gov

Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 75
<http://ost.em.doe.gov/tms>

The National Energy Technology Laboratory Internet address is <http://www.netl.doe.gov>

An Innovative Technology Summary Report (ITSR) for this innovative technology can be found at <http://www.em.doe.gov/plumesfa/intech/advwork/index.html>

For additional information, please visit Oceaneering Space System's website at <http://oceaneering.com/>